Analysis Tools Status

MicroBooNE DOE Review
Sept. 19, 2013

Analysis Tools Conveners
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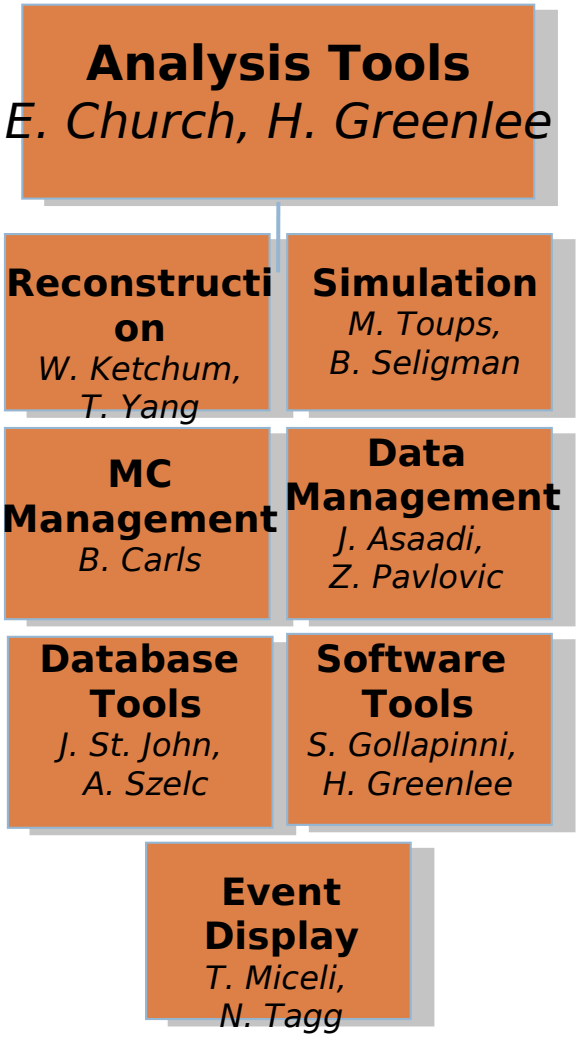
Outline

- Microboone Analysis Tools organization.
- Larsoft.
- First plots.
- Roadmap.
- MC Challenge.

Analysis Tools Organization



Analysis Tools

- The Microboone Analysis Tools Group holds weekly meetings at which all of the subgroups report.
  - Some of the subgroups hold their own meetings.
    - Reco group holds an informal weekly lunch discussion, as well as periodic “hack days.”
  - There is a lot of activity and enthusiasm.

SCD-LArSoft

- SCD now runs LArSoft
  - The new release paradigm and code management promises sharing of cross-experiment algorithms, while assuring stability to disruptions from one experiment to the other. Off-loads significant work to SCD.
  - MicroBooNE has had significant influence on this design

- There are once/month SCD LArSoft

Cross-Experiment reco/sim pollination

- There is a monthly General LArSoft meeting at which any important code architecture decisions which may impact MicroBooNE are vetted and algorithm development is shared. All four of us attend.

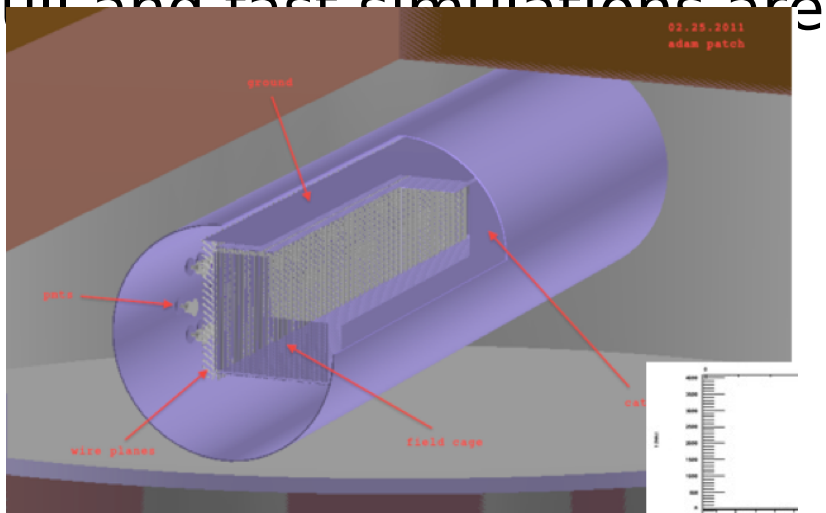
- The weekly LBNE Reconstruction/Simulation meeting is attended by Herb and Eric. They have much complicating nuance we don’t have!

MC Challenges

- Microboone has now had two "MC Challenges" in which we generated large samples of mc events of different types.
  - Single particles (all kinds).
  - Neutrino interactions (all kinds, booster and NUMI beam).
  - Cosmic rays (stand alone and overlaid on neutrino events).
  - Supernova.
- More recent MC challenge was in June 2013.
  - 35 different kinds of samples of 10,000 events each.
  - Samples processed through simulation and reconstruction.

MC Simulation

- Monte Carlo simulation is done in LArSoft
  - Neutrino flux
    - Booster Neutrino Beam (BNB)
    - Neutrinos at the Main Injector (NuMI)
  - Neutrino interaction: GENIE
    - Neutrino cross sections and final state interactions (FSI)
  - Particle propagation: GEANT4
  - Detector response: LArSoft
  - Optical system: LArSoft
    - Both full and fast simulations are available



MicroBooNE geometry

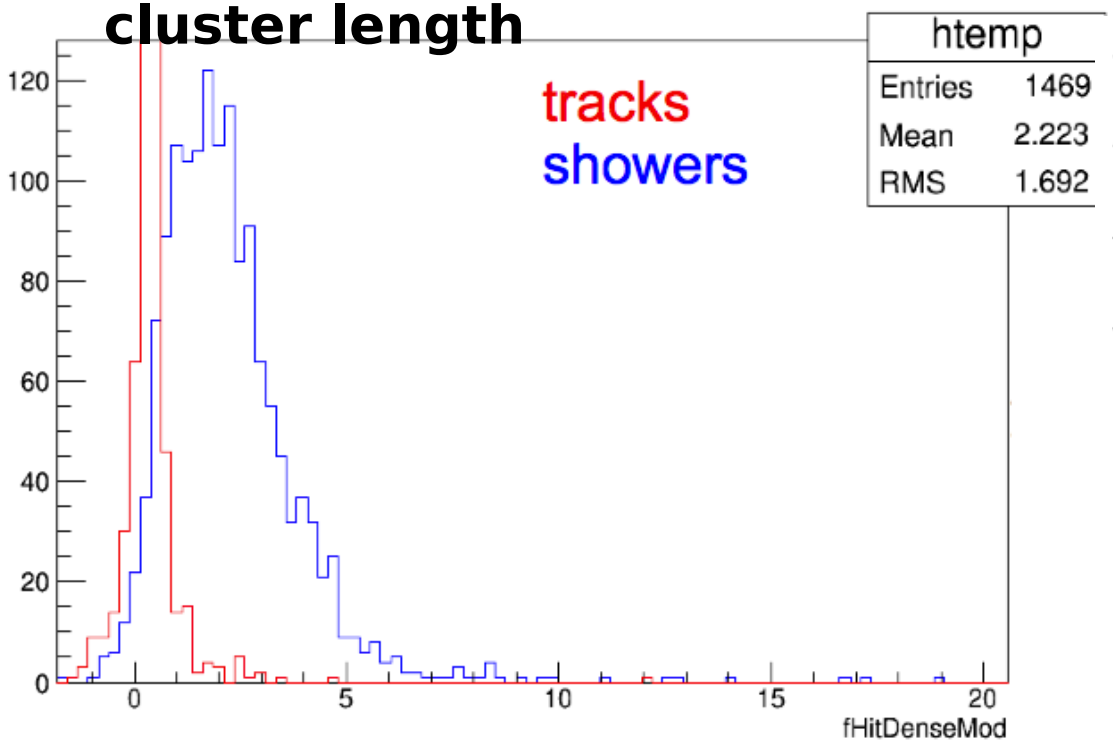
Shower Reconstruction Roadmap

Tasks

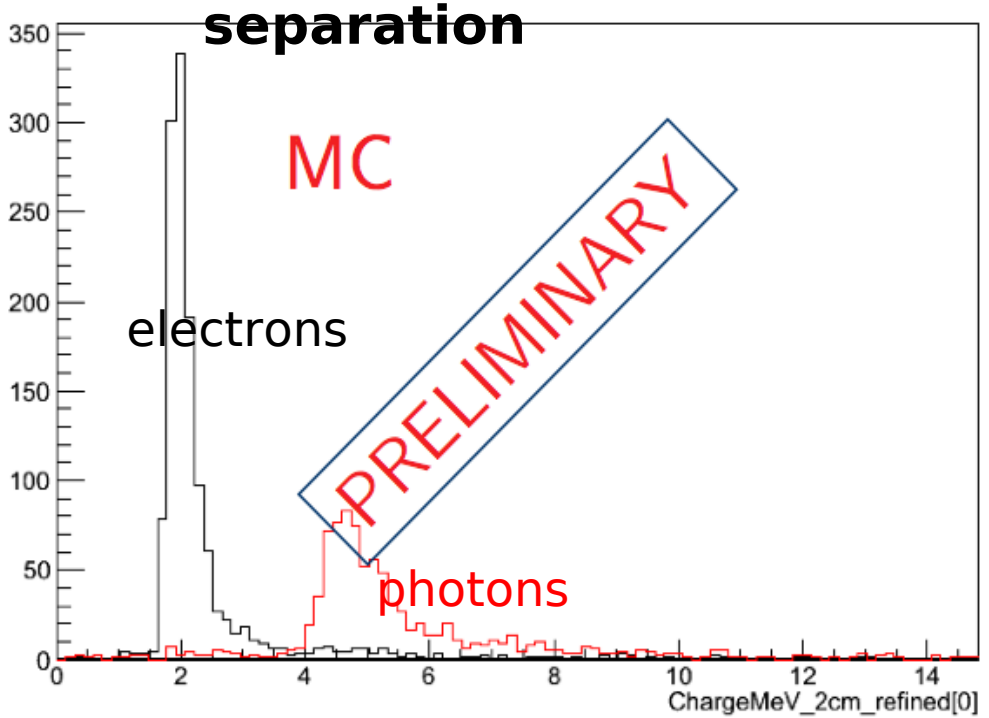
1. Cluster reconstruction (2D) *(Ben C.)*
    a. Optimization - include all the shower hits
    b. Remove short track (eg p) and fake clusters in the cluster
    c. Comparison of performance of different clustering algorithms (Cluster crawler, Fuzzy cluster, DBScan)
2. Single cluster shower reconstruction (2D) *(Andrzej)*
    a. Identify track-like or shower-like clusters *(with Ben C.)*
    b. Select events with at least 1 shower-like cluster/Reject events with only track-like clusters
    c. Shower start point (vertexing)
    d. Shower angle (done)

3. Shower reconstruction (3D) *(Andrzej, Wes, Tingjun)*
    a. Single cluster shower matching between different views
4. Energy calculation of shower *(Andrzej)*
    a. Check of calorimetric reconstruction (MIP vs highly ionizing vs other particles, including e)
    b. Recombination correction for overlapping hits (Birks/Box model)
    c. Correct for overlapping track and shower
    d. Uncontained shower
5. e/γ separation
    a. Based on dE/dx
6. Event reconstruction *(TBA)*

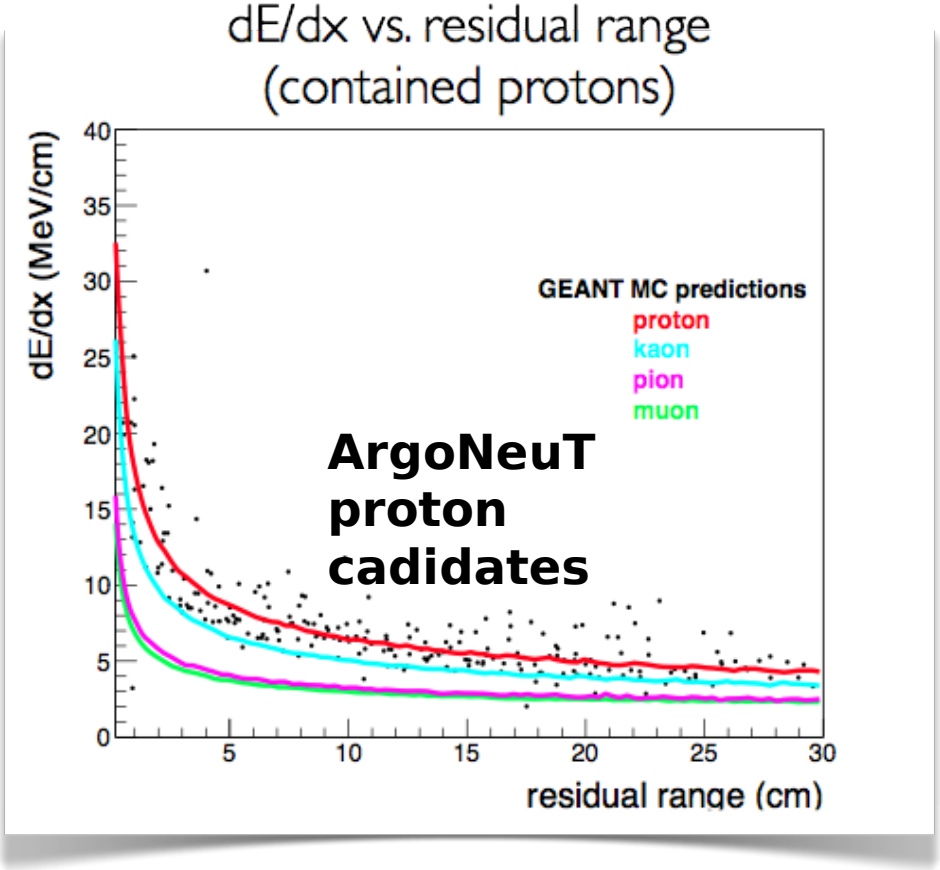
Track/shower separation based on number of hits per cluster length

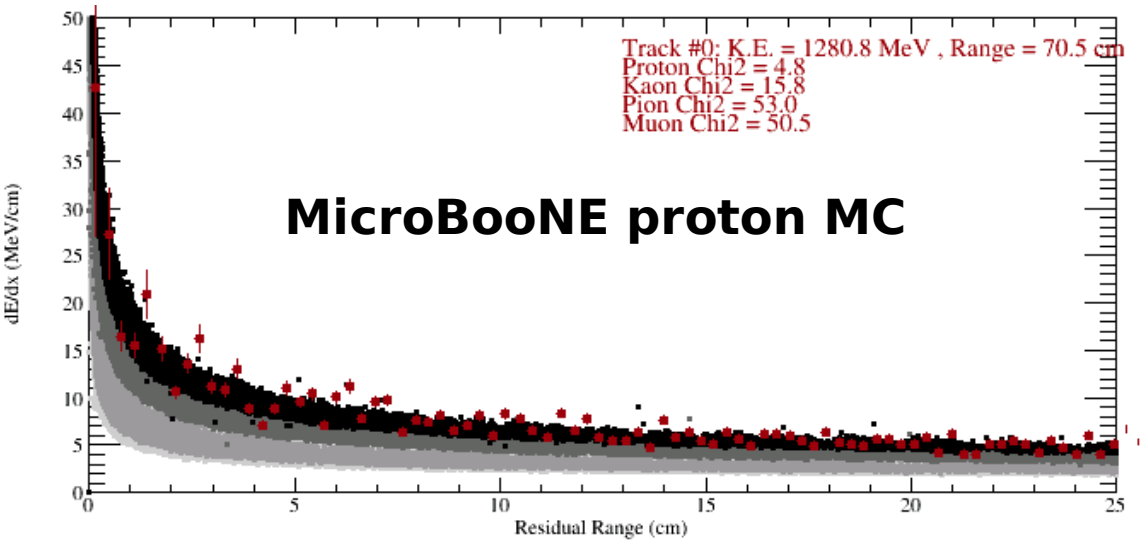


Electron/photon separation



Calorimetry





First Physics Plots

Goal: identify and prepare for early physics results to show with first data

- Aid in the validation of our commissioning efforts
- Provide early checks of our reconstruction and calibration tools
- Motivate and benchmark reconstruction for later analyses

Multiple datasets to work from

- Cosmic ray data
- NuMI beam data
- BNB data

A sample of our early plots

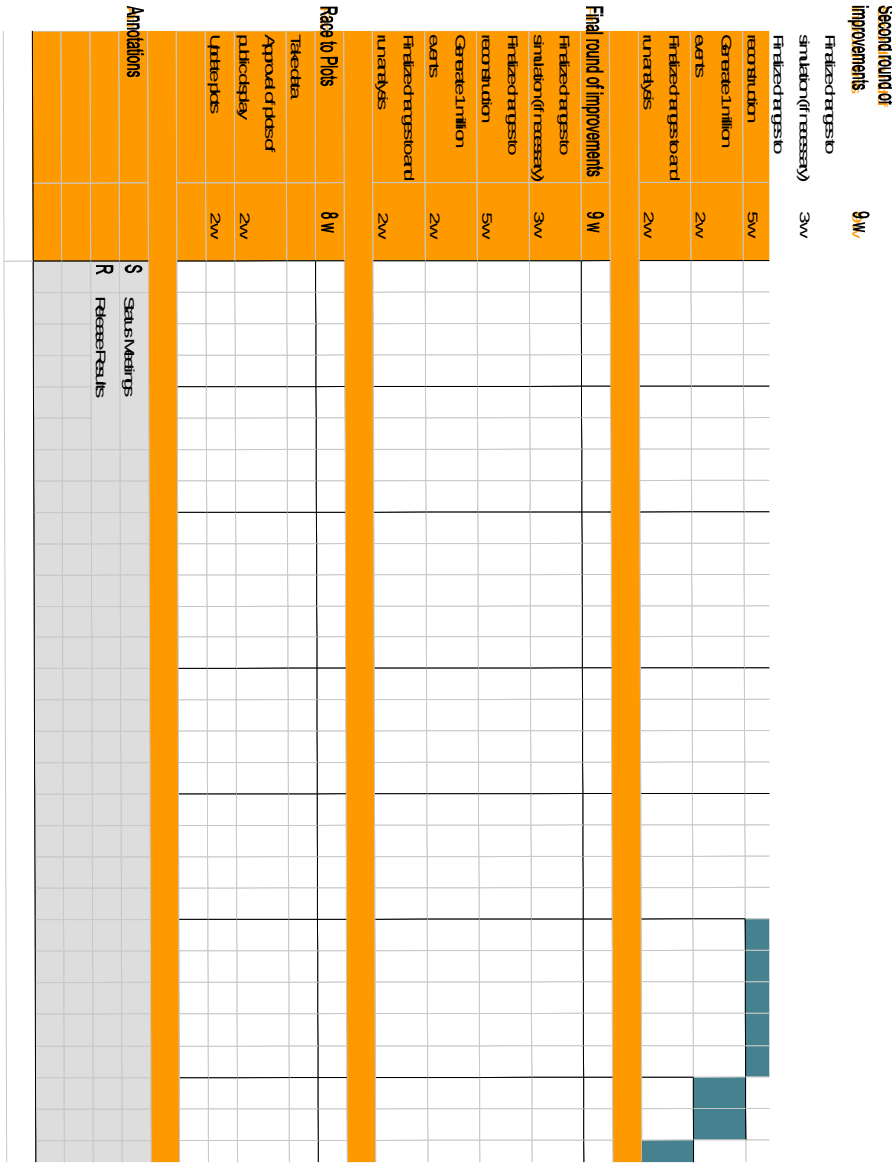
From cosmic-ray data

- Cosmic ray/shower rates
- Angular distribution of cosmic muons
- dQ/dx of cosmic muons
- Efficiency of cosmic removal

From neutrino-beam data

- Rate and angle of “beam” muons
- Neutrinos per proton on target
- Neutral pion mass distribution
  - From reconstructed photon-initiated showers
- dE/dx vs. residual range of charged particle tracks

Roadmap for cosmic ray analyses



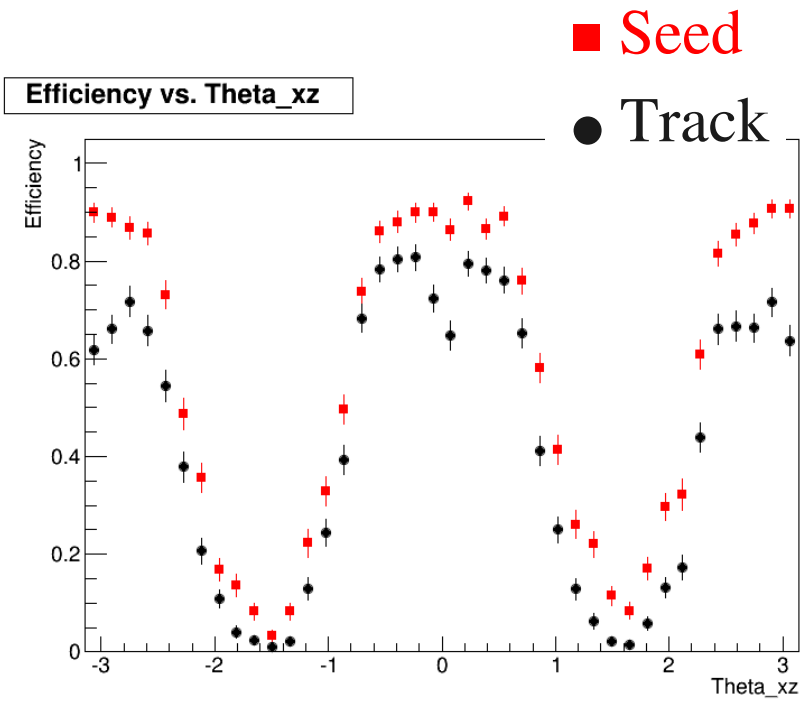
Progress on tracking

Reconstructing charged-particle tracks central part of experiment

- Reconstruction and removal of cosmic ray muons
- Identification of particles in neutrino interaction
  - dE/dx vs. residual range to do PID
- Determination of event kinematics

Analyzing performance on large samples

- Identifying where we need improvements
  - Near-vertical tracks (think cosmics) need improvement



Tracking movie!